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THE FIRST ZOEAL STAGE OF A HYDROTHERMAL VENT CRAB (DECAPODA: BRACHYURA: BYTHOGRAEIDAE)

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Abstract.—The first zoeal stage of a bythograeid crab is described. The zoea has numerous features that distinguish it from all known brachyuran larvae. These include the ornamentation of the carapace, abdomen, and telson, as well as details of the appendages. The zoeal morphology supports Williams' (1980) establishment of the superfamily Bythograeoidea.

The Bythograeidae comprise a new family of brachyuran crabs recently described from deep-sea hydrothermal vents in the eastern Pacific (Williams 1980). Adult, juvenile, and megalopal stages of *Bythograea thermydron* Williams have been collected from the "Galapagos Rift" study site (0°48.25′N, 86°13.48′W), where the adults are locally abundant. Adults of *B. thermydron* are also abundant at the "21°N" (20°49.6′N, 109°0.6′W) and "13°N" (12°48.85′N, 103°56.6′W) sites. Descriptions of two rare species in the family, one collected from both "13°N" and "21°N" and a second found only at "13°N," are in preparation (M. de St. Laurent, pers. comm.). The family Bythograeidae is the only family of brachyuran crabs known to occur in the vicinity of the vent sites.

A single brachyuran zoea attributable to this family was collected in a plankton tow 1 to 3 m above the area known as "Clam Acres" (20°49.6′N, 109°0.6′W; 2600 m) at the "21°N" vent site. The 35-minute multiple-circuit plankton tow was made by the DSRV *Alvin* (Dive 1218; 24 Apr 1982) using a Wishner (1980) opening-closing plankton net. Because of similarities between the morphology of the zoea and that of a prezoeal stage collected from a berried female bythograeid (as discussed below), this zoea is assigned to the family Bythograeidae. Identification to the specific level is not possible.

The zoea, mangled but nearly entire, was sorted from plankton and examined aboard the R/V *Melville* immediately after the sample arrived at the surface. Following preservation in buffered formalin, the zoea was stored in 70% ethyl alcohol. Illustrations were prepared with the aid of a Wild M-20 compound microscope with attached camera lucida. The zoeal and prezoeal specimens are deposited in the National Museum of Natural History, Washington, D.C. (USNM 210471, 210470, respectively).

Illustration of the general aspect of the zoea represents a composite of several drawings which rectify tortuous foldings of the body, appendages, and processes of the specimen. The presence of carapacial and telsonal spines or processes on the right or left sides was in some instances inferred by symmetry, as noted in the text.

Description of First Zoea

Carapace (Fig. 1).—Rostral-carapace length 0.48 mm; dorsal spine 0.36 mm. Rostral spine moderately elongate, extending beyond antennae; distal ⅔ bearing

appressed spinules. Dorsal spine stout, elongate, bearing 4 spinulose processes. Multiple spinulose and simple lateral spines present on body; precise number undeterminable. Two posterolateral spines and single anterolateral spine observed on right side of carapace, assumed by argument of symmetry to occur on left side. Eyes fused to carapace, with at least 5 processes of varying lengths on or near circumcorneal margin. Posterolateral margin of carapace fringed with fine hairs, anterolateral margin minutely denticulate, as illustrated.

Abdomen (Fig. 1).—Five somites, 1st naked, 2nd to 5th with 3 to 7 lateral processes per somite (precise number and symmetry of processes undeterminable).

Telson (Fig. 1).—Broadly bifurcate, right branch with 7 lateral and dorsolateral spines of unequal lengths and 3 submedial, dentate setae extending nearly length of furca. Distal ⅓ of furca with minute mesial spines regularly spaced. Details of left furca assumed by symmetry.

Antennule (Fig. 2A).—Short, swollen, with 3 aesthetascs, 1 subterminal seta.

Antenna (Fig. 2B).—Protopodite slender, elongate, with 2 rows of minute teeth; exopodite shorter, with 2 terminal setae, 1 elongate seta at midlength.

Mandible.—Not dissected.

Maxillule (Fig. 2C).—Endopodite 3-segmented; setal formula progressing distally: 1, 1, 4; basal endite with 3 stout spinose setae and 1 slender seta terminally, 1 slender seta laterally, and numerous hairlike setae as illustrated; coxal endite with 4 terminal, 3 subterminal slender setae.

Maxilla (Fig. 2D).—Endopodite unsegmented, with 3 + 4 setae, pubescence as illustrated; basal endite with 3 and 2 setae on distal and proximal lobes, respectively; scaphognathite with 4 plumose setae distally, terminating in a hirsute apical process.

Maxilliped I (Fig. 2E).—Ventromesial margin of basipodite with 3 plumose, 3 simple setae; endopodite with indistinct segmentation, setal formula progressing distally: 2, 1, 2, 4; left exopodite with 1 natatory plus 4 simple terminal setae, right exopodite not observable.

Maxilliped II (Fig. 2F).—Ventromesial margin of basipodite with 3 setae; endopodite and exopodite nascent, former with 2 terminal, latter with 4 terminal plus 1 lateral short, simple setae.

Color.—Devoid of pigmentation with exception of dark brown eyes.

Comparison with Prezoeal Stage

Several post-emergent, prezoeal specimens (carapace length approximately 0.25 mm), free of the embryonic membrane, were found entangled in the egg mass of an unidentified bythograeid crab from "13°N." The appendages and carapacial ornamentation (including rostral, dorsal, and lateral spines) of the prezoeae were undeveloped. Certain features of the prezoeal morphology, in particular the size, the presence of long, filamentous processes on the abdominal segments, and the distinctive, slender furcae and elongate setae of the telson, correspond to those of the planktonic zoea collected at "Clam Acres."

Remarks

The bythograeid zoea has numerous features that distinguish it from all known brachyuran larvae. The appressed spinulate condition of the dorsal, rostral, and lateral carapacial spines is unique to this zoea, as are the circumocular processes

Fig. 1. Bythograeidae, first zoea. Dorsal view, with carapace flattened and extended anterolaterally. Scale bar represents 0.1 mm.

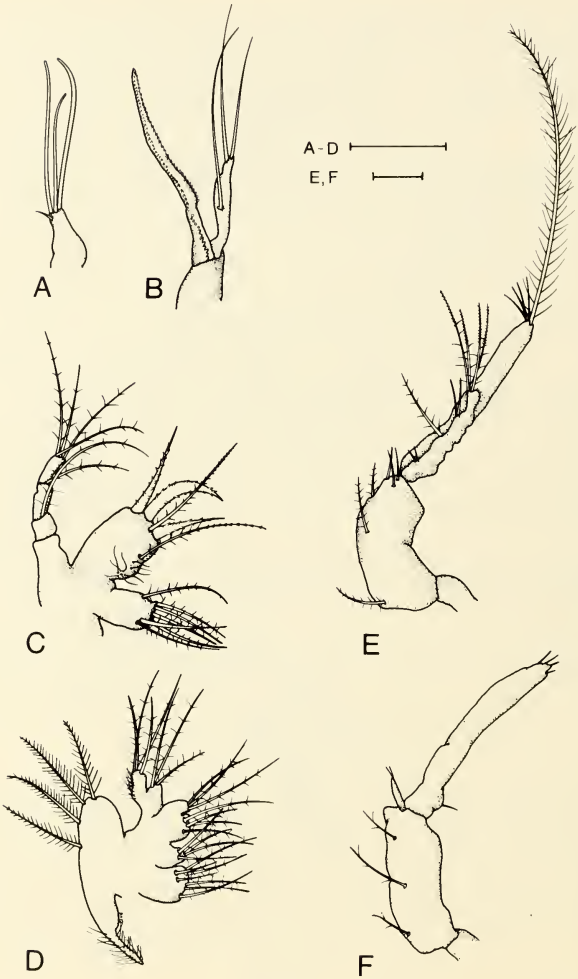

Fig. 2. Bythograeidae, first zoea. A, Antennule; B, Antenna; C. Maxillule; D, Maxilla; E, Maxilliped I; F, Maxilliped II. Scale bars represent 0.1 mm.

and paired posterolateral spines. Although multiple lateral spines occur in several species of Brachyura (e.g. ?*Dorynchus thomsoni* Norman (Williamson 1960, Rice 1980); *Cymonomus bathamae* Dell (Wear and Batham 1975)), details of the arrangement of these spines are not similar. Ornamentation of the carapacial margin in brachyuran zoeae is usually restricted to a sparse fringe of setae (e.g. *Thalamita danae* Stimpson (Fielder and Greenwood 1979)); marginal dentition is seen in a few brachyuran groups, including the Homolidae (e.g. *Homola barbata* (Fabr.), (Rice and Provenzano 1970)) and Raninidae (e.g., "raninid larva C," Rice 1970). The combination of a dense fringe of fine hairs posteriorly and fine dentition anteriorly, however, appears to be another character unique to the Bythograeidae. The asymmetric arrangement of the abdominal processes of the bythograeid zoea almost certainly reflects distortion of the specimen during collection. Although the precise arrangement of processes is undeterminable, it is clear that they are numerous and elongate. The abdomen of the zoea of ?*Dorynchus thomsoni* is superficially most similar to the bythograeid zoea in this respect. There is no counterpart to the telson of the bythograeid zoea among known brachyuran zoeae; the combination of elongate setae and numerous processes is unique. The obscure spination along the surface of the furcae is shared by the zoea of the raninid *Lyredius tridentatus* de Haan (Williamson 1965). Proportions of the antennal exopodite and spinous process correspond to those of the Cancridae, but details of the dentition and setation differ. The bythograeid maxillule is distinguished from that of other brachyuran zoeae by the 3-segmented endopodite. The 3 + 4 arrangement of setae on the endopodite of the maxilla is shared with certain members of the Cancridae (e.g. *Cancer productus* Randall; Trask 1970) and Xanthidae (e.g. *Cycloxanthops truncatus* (de Haan); Hong 1977). The maxillary scaphognathite is typical of the type found in the first zoeal stage of most Brachyura (type 7 of Van Dover, Factor, and Gore 1982). The single natatory seta of the exopodite and unsegmented condition of the endopodite of maxilliped I are uncertain features of the bythograeid zoea. It is possible that setae were lost during collection and that the segmentation of the endopodite is obscured by distortion of the specimen; alternatively, the zoea may be aberrant, displaying a combination of prezoeal and first zoeal characters with respect to the maxillipeds. The nascent condition of the endopodite of maxilliped II (assuming the specimen is a "mature" first zoea) is unique to the bythograeid zoea.

It is clear from the above discussion that the single known zoea of the Bythograeidae is not closely allied to any other brachyuran zoea. This larval evidence supports Williams' (1980) establishment of the superfamily Bythograeoidea based on features of the adult morphology of *Bythograea thermydron.*

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Addendum.—An additional larval specimen, sorted from washings of megafaunal material collected on *Alvin* Dive #1218 at "21°N," was received from Dr. Howard Sanders and Ms. Isabelle Williams, Woods Hole Oceanographic Institution. The larva, intermediate between a prezoea and first zoea, has morphological features which correspond in general to those of the bythograeid zoea described herein. Setal formula of basipodite, maxilliped I is 2,1,1,2; endopodite: 3,2,2,1,2,4+1; exopodite with 4 natatory setae. Maxilliped II lacks natatory setae, with 12–13 simple, short setae instead; endopodite with 1 basal, 1 subterminal seta, terminus damaged; basipodite naked. Variation between the two larval specimens probably reflects variation in abnormality rather than a difference in identity. Both larvae were collected on the same dive, from the same area, suggesting that they were from the same female and were collected only because they were abnormal and unable to swim away from the vent site.